

Neurological system
A&P review
Advanced Pathophysiology
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Overview

Structural

CNS (central nervous system)
PNS (peripheral nervous system)

Functional

somatic
autonomic

Cells of the neurological system

Neuron = transmit and receive electrical signals
Neuroglia = supportive

Nerve impulse

Neurotransmitters send signals over junction and synapse

Neural Plasticity:

Central nervous system

- 3 distinct regions >> forebrain— midbrain—hindbrain
 - 2 cerebral hemispheres which allow for conscious perception of internal and external stimuli, thought and memory processes, voluntary control of skeletal muscles
 - Deep portion is diencephalon ☐ processes incoming data
 - Midbrain >> motor and sensory tracts
 - Hindbrain >> allows sampling and comparison of sensory data from periphery and motor impulses
- Spinal cord >> nerve fiber connections from the brain to the periphery
- Protected by scalp, bony cranium, meninges, CSF, and vertebral column

Neuronal cells

Neuro stem cell
Neuroblast >> Neuron

Support cells

- Oligodendrocyte (CNS)
- Astrocyte (CNS)
- Neuroglia (CNS)
- Microglial (macrophage)

- Schwann Cell (PNS)

Neuroglial support cells/function

- Oligodendroglia
 - oligodendrocytes
 - Form the myelin sheath and neurolemma in the CNS
- Schwann cells
 - Form the myelin sheath and neurolemma in the PNS
- Microglia
 - Phagocytes of CNS; clear cellular debris
- Ependymal cells
 - Lining of the ventricles and choroid plexus, involved in CSF production
- Astrocytes
 - Form specialized junctions
 - Provide rapid nutrient transport
 - Believed to be essential for BBB
 - Believed to be a scar forming tissue
 - Seizure foci
 - Participate in the immune fxn of CNS
 - Appear to work w/ neurons in information and memory storage

Autonomic nervous system

- System of internal regulation for times of both rest (parasympathetic) and stress (sympathetic)
- Central control (especially hypothalamus and solitary nucleus) based on peripheral visceral afferent signals
- Primarily 2 neuron pathways
 - Preganglionic (brainstem/spinal cord) and Postganglionic (outside CNS)
 - Regulates involuntary actions
 - Internal organs (cardiopulmonary and GI)
 - Glands (lacrimal, Salivary, sweat)
- Neurotransmitters
 - Types include monoamines, amino acids and catecholamines

Neurotransmitters (be able to define, also label excitatory, inhibitory, mixed)

Acetylcholine:

GABA (gamma-aminobutyric acid):

Glutamate:

Glycine:

Dopamine:

Norepinephrine:

Serotonin:

Sympathetic

- Signals originate in the spinal cord intermediolateral column (T1 to L2)
- Energy expending (catabolic) system
 - activated in stressful situations (fight or flight)
 - Increases HR (chronotropic), heart contraction strength (ionotropic), BP, RR and bronchodilation
 - Increases pupil size
 - Stimulates salivary VISCOUS secretion
 - Stimulates sweat secretion
 - Stimulates liver gluconeogenesis and glycogenesis and fat lipolysis
 - Decreases gastrointestinal activity and secretion, and contracts gastrointestinal sphincters
 - Stimulates kidney renin release and adrenal medulla EPI release (Cholinergic postganglionic fibers)
 - Mediates ejaculation
 - Shunts blood flow to critical organs
 - Cardiac muscle and skeletal muscle vasodilation (beta-2 receptor)
 - Skin and gastrointestinal Vasoconstriction (alpha-1 receptor)

Parasympathetic

- Signals originate in the Sacral spinal cord (S2 to S4) and brain stem nuclei (cranial nerves 3,7,9,10)
- Energy conserving (anabolic) system
- activated in rest and relaxation situations
 - Decreases pupil size and contracts ciliary muscle (accommodation)

- Stimulates salivary WATERY secretion (contrast with viscous secretion by the sympathetic system)
- Decreases HR and BP
- Stimulates bronchoconstriction and Bronchial gland secretion
- Increases gastrointestinal activity and secretion, and relaxes gastrointestinal sphincters
- Stimulates urinary contraction
- Mediates erection

Somatic

- Motor and sensory tracts
- 12 pairs cranial nerves
- 31 pairs spinal nerves
- Motor neurons
- Afferent –transmit message to CNS
- Efferent –CNS to muscle/gland messages

Somatic Sensory function

- Peripheral sensory fibers respond to internal and external stimuli
- Touch, vibration, cold, warm, pain
- Via the ascending and synaptic relays, brings the stimuli to the sensory cortex
- Peripheral tissues generate an action potential in response to the stimuli and relay it to the central nervous system for interpretation.

Dermatomes /spinal innervation

- The surface of the skin is divided into specific areas called dermatomes, which are derived from the cells of a somite
- These cells differentiate into the following 3 regions:
 - myotome, which forms some of the skeletal muscle
 - dermatome, which forms the connective tissues, including the dermis
 - sclerotome, which gives rise to the vertebrae

Aging and the Nervous system

- Size and weight of brain decreased
- Fibrosis/thickening of meninges
- Decreased # of neurons and amount of myelin
- Increased permeability into blood -brain barrier
- Vascular changes

Common complaints and workup of the neurological system

Signs/symptoms neuro

Cognition/Mental status Impaired mental ability LOC Attention and concentration Memory Visual spatial perception Executive fxn Mood and thought content Muscle rigidity or Weakness Headaches	Tremor/seizures Sensory issues Visual Loss of sight or double vision Speech Language Aphasia Sensory issues Extremities Lack of coordination
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Tests of the neurological system

Brain imaging

CT, MRI/A

PET, SPECT

brain scan, cerebral angiography

spinal Xray

myelography

Echoencephalography(U/S), EEG, EP

CSF analysis

HEADACHES

SNOOP

- Features that should increase suspicion of a dangerous underlying headache or migraine mimic can be summarized using the mnemonic "SNOOP":
 - Systemic symptoms:
 - fever, weight loss
 - Neurologic symptoms or abnormal signs:
 - confusion, impaired alertness, or consciousness
 - Onset: sudden, abrupt, or split-second

- Older: new-onset and progressive headache, especially in patient over 50 years of age
- 4 "P"s
 - Pattern change (increased frequency)
 - Papilledema
 - Precipitating factors (Valsalva)
 - Positional aggravation

Evaluation of Dizziness

- nonspecific term and may be used by patients to indicate any of the following sensations:
- true vertigo
- lightheadedness
- Imbalance
- form of syncope/presyncope
- prevalence in the general population ranges=15% to 30%
- True vertigo is described as a rotary sensation of the patient or surroundings, and is often of vestibular origin
- Elderly population: up to 38% prevalence in the geriatric community
- Risk of falls, CVA, cervical neck D/O, deconditioning and medications
- usually, multifactorial

Symptoms of the peripheral system

- Patterns of generalized weakness that suggest a specific cause
- s/sx other than weakness that suggest a specific disorder or group of disorders
Deficits in a stocking-glove distribution, which suggest diffuse axonal disorders or polyneuropathy
- Fasciculation
- Hypotonia
- Muscle wasting without hyperreflexia
- Weakness that is progressive, chronic, and unexplained
- Weakness
- evaluation of the patient presenting with a complaint of "weakness" involves 3 steps:
 - Distinguishing true muscle weakness from motor impairment due to fatigue, pain, or stiffness rather than loss of muscle power
 - Localizing the site of the lesion within the neuromuscular system that is producing weakness
 - Determining the cause of the lesion

References

Advanced Physiology and Pathophysiology: Essentials for clinical practice

Basic Pathology 10th edition Robbins

Epocrates (various topics)

Emedicine.Medscape.com (various topics)

Pathoma.com

Pathophysiology -The biologic basis for Disease in Adults and Children –McCance and Heuther,
Brashers and Rote

Understanding Pathophysiology – McCance and Heuther

UP TO DATE (various topics)

Family Practice Notebook.com (various topics)